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MR imaging in evaluation of the temporomandibular lateral disc displacement in patients with posterior occlusion

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Summary

Background: The aim of this work was to assess the usefulness of MR imaging in the evaluation of temporomandibular lateral disc displacement in patients with posterior occlusion and the significance of the results of MRI in the diagnosis and treatment of posterior occlusion.

Material/Methods: Imaging evaluation was performed to 80 temporomandibular joints in 40 patients with posterior occlusion, of both sexes, at the age of 16-35, prior to orthodontic treatment. The imaging technique used for the evaluation of temporomandibular joints was magnetic resonance using the Signa Horizon 1.5 T System (GEMS) during rest occlusion. The evaluation was focused on bony structures of the joint and its posterior ligament. The type of joint was defined as intermediate in case of the articular tuberculum of a semicircular shape, shallow – in case of horizontally elongated ellipse, and deep – in case of vertically elongated ellipse. The symmetry of the articular space as well as the alignment of the articular disc in the frontal plane was also evaluated. The obtained data were presented in form of figures and graphs and analysed using the statistics software – BMDP New System 2.0.

Results: In patients with posterior occlusion, the so-called intermediate type of temporomandibular joint was found to be the most common, whereas the symmetrical articular space occurred in 33.7% of cases. The rate of narrowed retrodiscal region was 61.2%, which was a statistically significant difference in comparison with the control group. The assessment of position of the disc in the frontal plane during occlusion revealed 12.6% of medial displacement and 6.2% of lateral displacement. Statistically significant differences between the study group and the control group were found concerning the disc position during occlusion assessed in the frontal plane (χ^2=9.564; p=0.008). Statistically significant differences were confirmed concerning the width and symmetry of the articular space between the two groups – the persons with posterior occlusion and the control group (χ^2=24.174; p=0.0001). In persons with posterior occlusion no significant correlation was found between the type of the joint and the position of the articular disc during occlusion in the frontal plane, that is the lateral and medial displacement (χ^2=2.529; p=0.640). Correlation was found between the type of the joint and its symmetry, narrowed or widened articular space in the retrodiscal region (χ^2=15.54; p<0.004).

Conclusions: Diagnostic efficacy of the magnetic resonance imaging was found in the evaluation of temporomandibular joints in case of posterior occlusion. Based on the obtained results we believe that in MR of occlusion defects T2-weighted sequences can be excluded, as the application of only T_1- and PD-weighted sequences is sufficient.

Key words: Temporomandibular joint • lateral and medial disc displacement • MR imaging • posterior occlusion

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Background

Malocclusions are anomalies of upper and lower jaw occlusion with deviation to one of the three spatial planes – frontal, sagittal or transverse/horizontal. In 80 % of cases they are acquired, caused by exogenous factors. Malocclusions cause dysfunction of the whole masticatory organ, maintain wrong functional patterns for all groups of muscles within the cranioface as well as functional conditions of temporomandibular joints, what often leads to permanent morphological lesions in within [1, 2, 3].

Location of temporomandibular joints just below the skin is very convenient for examination with the use of magnetic resonance. The MR enables to obtain very good one-stage visualization of soft tissues and good enough of osseous tissues of the joint [4, 5, 6, 7].

The temporomandibular joint is mainly built of tissues of relatively short T2 values (fibrous cartilage, muscles, fat and cortical bone). If the echo time (TE) is short – less than 20 ms – the MR precisely shows the anatomic condition of the joint. If the repetition time (TR) is also short – less than 500 ms – T1-weighted images of good quality are obtained. In such conditions the contrast between tissues is enhanced with stronger signal from the adipose tissue compared to the muscles. T2-weighted images are useful in searching of pathological fluid in joint or tissues surrounding it. For T2-weighted images the value of TR is around 2000 ms, while the TE is elongated to 80–120 ms. It results in stronger signal from the fluid in relation to the adipose tissue. T2-weighted images elongate the time of examination due to long TR duration [8, 9].

In case of temporomandibular joints imaging it is standard to use the spin-echo technique. On the other hand, the scanning time is shorter in the gradient-echo than the spin-echo technique. Although the articular disc is well seen, the surrounding structures are not as visible as on the spin-echo images. Short duration of the exam can be used for a function test. It is performed on T1-weighted images, during gradual opening of the mouth [9, 10, 11].

Images of joints showing full range of movement are possible for the cine-loop imaging method, where all sequences are made in one plane, whereas the patient opens his mouth with the use of a special device [9, 12, 15]. The quality of sequences determines the duration of the exam and fluency of the obtained film (the CINE option). The cine-loop method is based on the gradient-echo technique which is characterized by shorter duration of the exam. Images obtained by means of the method give fewer anatomical details than the spin-echo technique. Acquisition of a fluent image of movement requires at least 12 images per second. However, most authors evaluate the mobility of joint on statistical images, with the use of examinations performed with opened and closed mouth [5, 10].

The MR images of temporomandibular joints can contain artifacts with the origin in carotid and maxillary artery. In order to minimize the presence of such artifacts presaturation pulses ought to be applied, as they remove additional magnetization which is produced during fluids flow. The best visualization of the articular disc, especially of its lateral and medial parts, is obtained when the examined plane leads through posterior band in closed mouth position. Although joint images in frontal plane do not precisely show the anatomy of medial area of the disc, they ought to be performed in order to visualize lateral and medial part of articular disc [12, 13, 14].

The aim of this study is to evaluate the usefulness of MR examination in diagnostics of lateral displacement of temporomandibular disc in occlusion in patients with posterior occlusion and to assess the significance of the results in diagnostics and treatment of posterior malocclusions.

Materials and methods

The material comprised 50 patients in whom 100 temporomandibular joints were examined. 10 patients (20 joints) aged 18–35 (mean age 23.9) with no ailments or lesions in orthodontic examination constituted the control group. 4 of them were men, 6 were women. 40 patients aged 16–35 (mean age 24.4) were referred to the Department of Orthodontics, Institute of Dentristry, Collegium Medicum, Jagiellonian University, with diagnosis of posterior occlusion, prior to orthodontic treatment. Among them 26 were men and 14 were women. In this group, 80 temporomandibular joints were examined.

The MR examinations were carried out using the Signa Horizon 1,5T device (GEMS). Dedicated coils with diameters of 8.5 cm were used, individually for every joint. Imaging was performed in T1, T2 and PD sequences, in planes perpendicular to the axis of long mandibular condyle, in layers of 3 mm and 0.3 mm of space between the layers, and in planes parallel to the axis of long mandibular condyle in layers of 2 mm with spaces of 0.2 mm. Location of the disc was assessed in resting condition in frontal plane. Contrast agent was not used.

All findings were evaluated with reference to the condition of osseous structures in the temporomandibular joint, articular process, symmetry of articular space and location of articular disc in frontal plane. Position of the disc was marked as normal, lateral or medial.

The obtained data were presented in tables and diagrams and evaluated statistically. For description of quantitative features we used arithmetic mean (x), standard deviation (s), minimum value (min) and maximum value (max).

Qualitative features were presented in contingency tables including the number of cases in particular category (n) and percentage (%). In tables describing the differences between features in the study and control group, the percentage was calculated in relation to the headcount of each group. The assessment of age differences between the control and study group was carried out using the χ^2 test and χ^2 test with Yates' correction. Calculations were made with the use of statistical package of BMDP New System 2.0.

Results

The analyzed material showed 3 types of structure of the temporomandibular joints: shallow, intermediate and deep. The most frequently observed type was intermediate and concerned 64 joints (80%) in the study group and 20 joints (100%) in the control group (χ^2=4,762; p=0,093). The results are shown in table 1. Symmetrical articular space in occlusion was found in 27 joints (33.7 %) in the study group and in 19 joints (95%) in the control group. In patients of the study group (61.2%) narrowing of the articular space in retrodiscal region was observed in 49 joints and it's widening in 4 cases (5%). In patients of the control group the image of articular space was symmetrical in 19 cases (95%). The results are shown in table 2. Significant differences of width and symmetry of articular space between both studied groups – patients with posterior occlusion and control group – were confirmed statistically (χ^2=24,174; p=0,0001).

Position of the disc in occlusion analyzed with the use of MR in frontal plane in patients with posterior occlusion proved to be normal in 65 joints (81.25%) of the study group (fig. 1) and 13 joints of the control group (65%). Lateral displacement (fig. 2) concerned 5 cases (6.25%) of the study group and 6 (30%) of the control group. Medial displacement

Table 1. The frequency of various types of the joint in the study and control groups in MRI.

Group	Type of joint						Total	
	Shallow		Intermediate		Deep			
	Number	%	Number	%	Number	%	Number	%
Study	8	10,00	64	80,00	8	10,00	80	100,00
Control	0	0,00	20	100,00	0	0,00	20	100,00
χ^2=4,762; p=0,093								

Table 2. The symmetry of the articular space during occlusion in the study and control groups in MRI.

Group	symmetry of the articular space						Total	
	symmetrical		Narrowed in the retrodiscal area		Widened in the retrodiscal area			
	Number	%	Number	%	Number	%	Number	%
Study	27	33,70	49	61,20	4	5,00	80	100,00
Control	19	95,00	1	5,00	0	0,00	20	100,00
χ^2=24,174; p=0,0001								

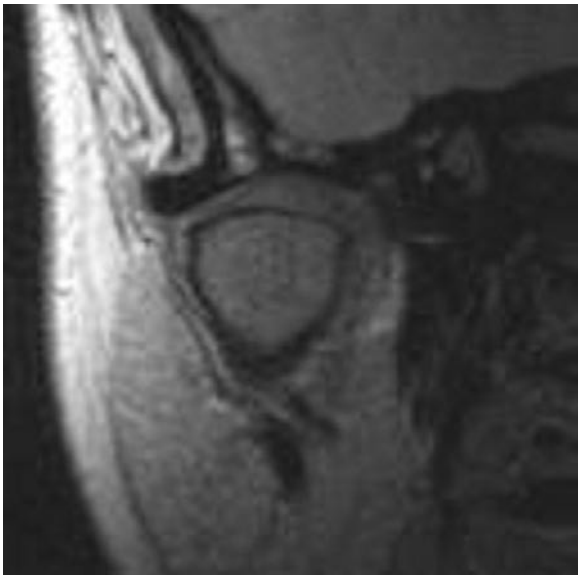

Figure 1. MR imaging, PD-sequence of the temporo-mandibular joint during occlusion in the frontal plane. The correct position of the articular disc: the acetabulum (<), the mandibular condyle (<<), the articular disc (<<<).

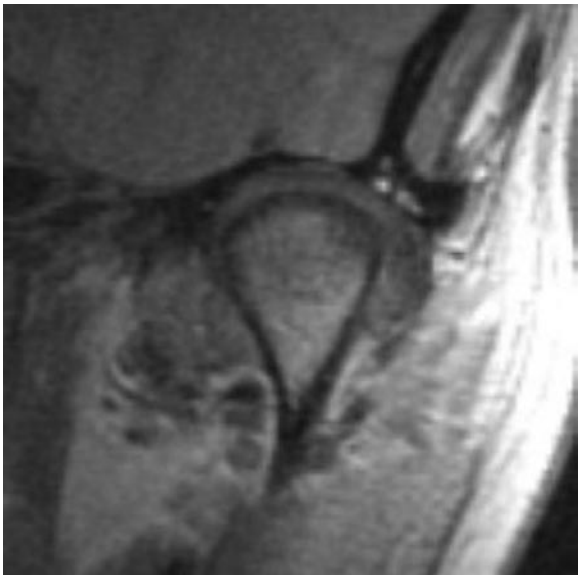

Figure 2. MR imaging, PD-sequence of the temporo-mandibular joint during occlusion in the frontal plane. Lateral disc displacement (<).

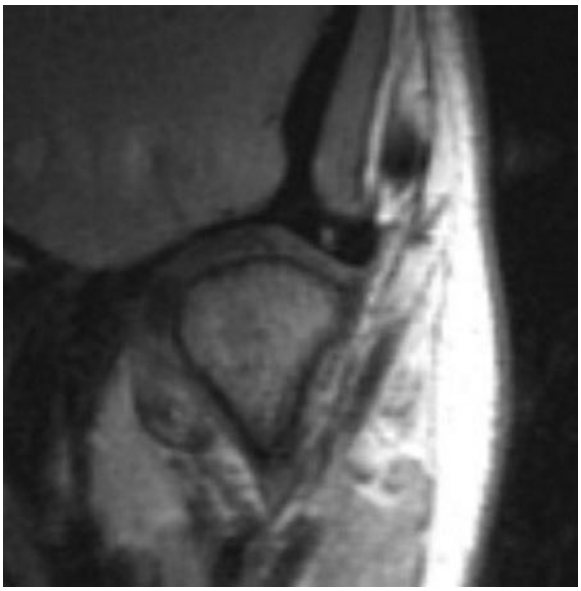

Figure 3. MR imaging, PD-sequence of the temporo-mandibular joint during occlusion in the frontal plane. Medial disc displacement (<).

(fig. 3) was found in 10 joints (12.5%) in the study group and 1 joint (5%) in the control group. For results see table 3. Statistically significant differences concerning location of the disc in occlusion, examined in frontal plane, were stated between the studied groups (χ^2=9,564; p=0,008).

The analysis of position of the articular disc during occlusion (frontal plane images), its lateral and medial displacement in relation to the type of articular structure and symmetry of articular space was performed on the basis of data obtained from the MR examination of the group of patients with posterior occlusion. For results – see tables 4, 5 and 6.

In patients with posterior occlusion no significant corelation was stated between the type of joint and position of the disc during occlusion in frontal plane, meaning the lateral and medial displacement (χ^2=2,529; p=0,640). Relation between type of joint and its symmetry, articular space narrowed or widened within the retrodiscal area was stated (χ^2=15, 54; p < 0,004). No significant correlation was stated between the symmetry of the articular space, its narrowing or widening within the retrodiscal area and position of disc during occlusion, examined in frontal plane (χ^2=6,10; p=0,192).

Discussion

The use of magnetic resonance for evaluation of the morphological image and functional lesions of temporomandibular joints in patients with posterior malocclusions enabled one-stage, non-invasive and precise diagnostic imaging. The MR visualized internal structures significant for the mechanics of joint. It allows imaging of the bilaminar space being a potential cause of temporomandibular arthrosis in posterior occlusions, which results from chronic compression of retrodiscal tissues and disorders of blood supply and innervation of cartilagino-ligamentous parts of the joint.

Epidemiologic examinations point at high incidence of articular dysfunctions of varied intensity, which can amount to as much as 60 % in children. Abnormalities of structure and location of the articular disc are often believed to be the reasons for dysfunctions of temporoman-

Table 3. The position of the disc during occlusion in the frontal plane in the study and control groups in MRI.

Group	The position of the disc during occlusion in the frontal plane						Total	
	Normal		Lateral displacement		Medial displacement			
	Number	%	Number	%	Number	%	Number	%
Study	65	81,25	5	6,25	10	12,50	80	100,00
Control	13	65,00	6	30,00	1	5,00	20	100,00
χ^2=9,564; p=0,008								

Table 4. Correlation between the occurrence of various disc positions during occlusion in the frontal plane and the image of the articular space in the study group.

Type of joint	disc position during occlusion in the frontal plane						Total	
	normal-		Lateral displacement		Medial displacement			
	Number	%	Number	%	Number	%	Number	%
Shallow	6	75,0	1	12,5	1	12,5	8	100,0
Intermediate	51	79,7	4	6,2	9	14,1	64	100,0
Deep	8	100,0	0	0,0	0	0,0	8	100,0
χ^2=2,529; p=0,640								

Table 5. Comparison of the type of joint with the image of articular space during occlusion in the study group.

Type of joint	Symmetry of articular space in occlusion						Total	
	Symmetrical		Narrowed in retrodiscal area		Widened in retrodiscal area			
	Number	%	Number	%	Number	%	Number	%
Shallow	7	87,5	0	0,0	1	12,5	8	100,0
Intermediate	19	29,7	42	65,6	3	4,7	64	100,0
Deep	1	12,5	7	87,5	0	0,0	8	100,0
χ^2=15,54; p<0,004								

Table 6. Correlation between the disc position in the frontal plane and the image of the articular space in the study group.

Articular space	disc position in the frontal plane						Total	
	normal		Lateral displacement		Medial displacement			
	Number	%	Number	%	Number	%	Number	%
Symmetrical	23	85,2	1	3,7	3	11,1	27	100,0
Narrowed in the retrodiscal area	40	81,6	4	8,2	5	10,2	49	100,0
Widened in the retrodiscal area	2	50,0	0	0,0	2	50,0	4	100,0
χ^2=6,10; p=0,192								

dibular joints [14, 15, 16, 17, 18, 19]. As for incidence of the dysfunctions – no differences were found between the sexes [17, 19]. The influence of occlusal factors on the formation of dysfunctions remains unclear. Adaptation processes lead to displacement of the articular disc and morphological rebuilding of the joint, but malocclusions are not their only cause [19, 20, 21, 22].

Own examinations included the assessment of type of the joint, symmetry of articular spaces, narrowing and widening within the retrodiscal area, normal position of the articular disc, lateral and medial displacements in patients with posterior occlusion. The exams were carried out in groups similar regarding the age and sex. Symmetrical articular space was found in 33.7% of patients with malocclusion. This group presented high percentage of narrowing within the retrodiscal area which amounted to 61.25%. Statistically significant difference concerning the incidence of narrowing within the retrodiscal area between the study and control groups suggests correlation between occurrence of malocclusions and articular space narrowed in the retrodiscal region. The assessment of position of the articular disc examined in frontal plane during occlusion enables observation of lateral and medial displacement. In the study group 12.5 % of medial and 6.25% of lateral displacements were stated. Other authors present data similar to ours, with 14.7–20.8% of medial displacements and 5.6–12.5% of lateral displacements [23, 24]. The relations between the examined structures of temporomandibular joints in patients with posterior occlusion that we studied result in relationship between the type of joint and narrowing or widening within the retrodiscal area. In patients with posterior occlusion the narrowing occurs within the retrodiscal region. Most retrodiscal narrowings concern the intermediate type of joint.

Results of examinations carried out by certain authors show correlation between medial displacement of the disc in patients with posterior occlusion and emphasize the relation between intra-articular dysfunctions with anomalies of articular space symmetry [19, 20, 23]. Results of the exams performed in this study did not prove the relationship between lateral and medial displacement examined in frontal plane in patients with posterior occlusion, and the type of joint along with joint symmetry anomalies. Normal position of the disc was observed in the symmetrical space and the space narrowed within the retrodiscal area.

Standard diagnostic protocols for temporomandibular joints suggest examinations of T1, T2 and PD-weighted images in sagittal planes with opened and closed jaws [4, 5, 7, 25, 26]. These images enable assessment of the articular disc, condition of articular ligaments and osseous structures of joints, as well as possible presence of fluid inside the joint. According to most authors, temporomandibular joints ought to be examined also in the frontal plane, what makes it possible to assess lateral and medial displacements of the disc, significant in cases of evaluation of mobility dysfunctions [13, 22]. Such exam is carried out separately for each joint, whereas the acquisition of imaging data in all sequences during occlusion requires about 45 minutes. Because of the noise generated by working gradient coils, the patient's ears are protected with the use of wax earplugs. Observation of the examined patients leads to the conclusion that most of them tolerate the duration of the exam but movement artifacts caused by tiredness are frequent. Moreover, the problem impossible to solve is claustrophobia which concerns 2–3% of patients.

If the MR diagnostics is necessary, such patients ought to be examined in open MR imaging units, which use different

kind of magnet configuration and only the patient's head remains inside the unit. Based on own experiences, it can be stated that time-consuming T2-weighted sequences are not necessary for MR diagnostics of malocclusions and it is sufficient to use only the T1 and PD-weighted images which visualize the joint surfaces, the articular disc and articular ligaments. In order to the fact that these structures contain small amount of water, they are hypointense in all sequences [26, 27].

Conclusions

1. Examination of temporomandibular joints in frontal plane in patients with posterior malocclusions enables one-stage imaging of the narrowing in the retrodiscal region with reference to the type of joint and medial or lateral displacement of the articular disc.

2. In MR diagnostics it is possible to omit the T2-weighted sequence and perform only the T1 and PD-weighted sequences, or only the PD sequence, as they are sufficient to visualize the surface of joints, articular disc and ligaments.

3. Current imaging possibilities for early dysfunctions of temporomandibular joint using the magnetic resonance can directly influence the improvement of orthodontic treating methods.

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